INDOOR AIR QUALITY ASSESSMENT

Massachusetts Department of Employment Training
Massachusetts Department of Transitional Assistance
Massachusetts Rehabilitation Commission
Job Training and Employment Corporation

Career Opportunities
77 High School Road Extension
Hyannis, Massachusetts

Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health Assessment
Emergency Response/Indoor Air Quality Program

July 2003

Background/Introduction

At the request of Martha Goldsmith, Director of Learning, Division of Capital Assets Management (DCAM), the Bureau of Environmental Health Assessment (BEHA) of the Massachusetts Department of Public Health (MDPH) was asked to provide assistance and consultation regarding conditions at Career Opportunities, 77 High School Road Extension (the building), in the Hyannis section of Barnstable, Massachusetts. This facility current houses several public agencies, including the Massachusetts Department of Employment Training (MDET) Massachusetts Department of Transitional Assistance (MDTA) and the Massachusetts Rehabilitation Commission (MRC). Job Training and Employment Corporation (JTEC) also have workspace within this building. Concerns about water damage to the interior of the building and possible mold contamination prompted the request.

On June 27, 2003, a visit was made to the building by Michael Feeney, Director of Emergency Response/Indoor Air Quality (ER/IAQ), BEHA, to conduct an indoor air quality assessment. John Byrnes, Project Manager, DCAM, and Gerald Covino, Manager of Property Planning and Development, MDET, accompanied Mr. Feeney during the assessment

The building was constructed as an indoor roller skating rink in the late 1960s-early 1970s. The original structure consists of painted cinderblock exterior wall (see Picture 1), built on a cement slab. The original building was covered with a rubber membrane peaked roof (see Picture 2). It was converted into office space in 1998. It appears that the conversion included:

- Construction of an addition to the front of the building, thereby expanding the footprint to create more office space (see Picture 3);
- Installation of a roof for the aforementioned addition. Note, this new roof is installed below the edge of the original building's roof (see Picture 4);

- Installation of heating ventilating and air conditioning (HVAC) equipment;
- Installation of windows in openings cut into existing cinder block walls (see Picture 5). Note, windows in the building are not openable. Air movement is entirely dependent on mechanical ventilation;
- Installation of gypsum wallboard (GW) along exterior cinder block walls to form interior walls and windowsills (see Picture 6); and
- Installation of wall-to-wall carpeting.

Methods

Air tests for carbon dioxide, temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor. Water content of GW was measured using a Delmhorst, BD-2000 Model, Moisture Detector with a Delmhorst Standard Probe. Moisture measurements were taken beneath windowsills and in cavities within some interior walls. Tests were taken during normal operations.

Results/Discussion

Ventilation

It can be seen from Table 1 that the carbon dioxide levels were above 800 ppm in all areas sampled, which indicates inadequate air exchange across the facility. Ventilation is provided by air handling units (AHUs), located above the suspended ceiling of the original structure and within a mechanical room in the southeast corner of the building. The AHUs are connected to ductwork, also located above the ceiling. The ductwork distributes air to ceiling mounted air diffusers. Air diffusers are designed to create airflow by directing air to move along the ceiling and walls, subsequently allowing it to mix and circulate. No exhaust system was identified at the time of inspection. Without exhaust ventilation, indoor air pollutants can build up and lead to indoor air quality/comfort complaints.

To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of building occupancy. In order to have proper ventilation with a mechanical supply and exhaust system, the systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. The date of the last servicing and balancing was not available at the time of the assessment. It is recommended that existing ventilation systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994).

The Massachusetts Building Code requires a minimum ventilation rate of 20 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week, based on a time-weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches. For more information concerning carbon dioxide, please see Appendix I.

Temperature readings ranged from 72^{o} F to 79^{o} F during the assessment, which were very close to the BEHA recommended comfort guidelines. The BEHA recommends that indoor air temperatures be maintained in a range of 70^{o} F to 78^{o} F in order to provide for the comfort of building occupants. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply.

The relative humidity ranged from 43 to 55 percent, which was within the BEHA recommended comfort range in all areas surveyed. The BEHA recommends a comfort range of 40 to 60 percent for indoor air relative humidity. Relative humidity in the building would be expected to drop during the winter months due to heating. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

In order for building materials to support mold growth, a source of water exposure is necessary. Identification and elimination of water moistening building materials is necessary to control mold growth. Identification of the location of GW with increased moisture levels can also provide clues concerning the source of water supporting mold growth. GW with increased moisture content over normal concentrations may also indicate possible presence of mold growth.

In an effort to ascertain moisture content of GW in the building, samples were taken in rooms along the north and east sides of the building where GW was not blocked with office furnishing. A Delmhorst probe was inserted into the surface of GW mounted around windows, as well as through interior walls. The Delmhorst probe is set to sound a signal when a moisture reading $\geq$ 0.5 percent in GW is detected.

Please note moisture content of GW is measured in a real time measurement of the conditions present in the building at the time of the assessment. The building was evaluated on a sunny day, with an outdoor temperature of 77 ^{o} F to 79^{o} F and relative humidity of 63 to 75 percent. Prior to the assessment, the last measurable rain in the Barnstable area was June 22, 2003, five days prior to the assessment date of June 27, 2003. Moisture content may increase or decrease depending on building and weather conditions. For example, during the normal operation of a heating, ventilating and air-conditioning (HVAC) system, moisture is introduced into a building during weather with high relative humidity. As indoor relative humidity levels increase, porous building materials, such a GW, can absorb moisture. The moisture content in GW can fluctuate with increases or decreases in indoor relative humidity.

No active leaks were observed, however, accumulated moisture was noted on walls. GW windowsills on nearly every window throughout the building showed sign of bubbling and/or efflorescence (see Pictures 7 and 8). Efflorescence is a characteristic sign of water damage to building materials such as brick or plaster, but it is not mold growth. As moisture penetrates and works its way through mortar around brick, water-soluble compounds in bricks and mortar dissolve, creating a solution. As the solution moves to the surface of the brick or mortar, water evaporates, leaving behind white, powdery mineral deposits. Carpeting beneath windows also appeared to be water stained.

Additionally, Room 104 had visible mold growth on GW beneath the windowsill (see Picture 9). GW under window frames in rooms 104, 105 and 106 had moisture content measurements $\geq$0.6 percent around window frames. Moisture measurements indicate that GW under window frames was saturated. Other GW not adjacent to windows all had measurements below 0.5 percent. Of note was the moisture measurement taken through the plastic wall coving in room 106. This measurement indicates that GW below the plastic coving remained moistened for over 96 hours beyond the last rainstorm in Barnstable.

The American Conference of Governmental Industrial Hygienists (ACGIH) recommends that porous materials be dried with fans and heating within 24 hours of becoming wet (ACGIH, 1989). If porous materials are not dried within this time frame, mold growth may occur. Once mold growth has occurred, disinfection of these materials may be possible. Since GW is a porous surface, disinfection is likely to be ineffective.

Moisture in the indoor environment can originate from several sources. One possible source of moisture in GW may be introduction through leaks in window frames and spaces in the exterior walls. Window frames and sealed openings in exterior walls on the north south and west walls of the building had a number of holes or cracks in sealant seams that can allow water to penetrate into the interior of the building (see Pictures 10a and 10b). Spaces in window gaskets are also a pathway for moisture migration (see Picture 10c).

It appears there is several means by which rainwater penetrates from the exterior walls of the addition at the front of the building into the interior of the building. The building envelope is composed of exterior walls, window systems, door systems and roof systems. The exterior cladding of the addition appears to be cedar shingle framed by white painted planking (see Picture 11). A seam is formed where dissimilar materials meet. These junctions require sealing to prevent water penetration. It is a common practice to install flashing in the joints where dissimilar building materials are used in the building envelop. The flashing functions as a transitional surface for rainwater to drain from one surface to another (e.g. in a manner similar to layering shingles on a roof). Flashing was installed along the top of a window frame (see Picture 12) and at the shingle/planking junction above the building slab (see Picture 13). Of note is the lack of flashing beneath the window frames (see Picture 14). This lack of flashing creates an open seam (see Picture 15) that can allow for water penetration into the building interior. The collection of water against the window frame in this vulnerable spot is enhanced by window boxes affixed beneath the window seams. As rainwater pours onto the shingles and frames, water accumulates behind the window boxes, resulting in chronic wetting and degradation of building materials.

The configuration of the roof system in the front of the building may provide another means for water penetration. Prior to the assessment, building occupants reported that water damaged ceiling tiles were replaced, mostly in areas that are within the footprint of the addition (areas 101, 102, 104, 105, 149, 150, 152 and 185; see Figure 2). The location of water damaged ceiling tiles suggests water is penetrating from an external source. As previously mentioned, the addition's roof is not flush with the original roof, but rather is installed a foot below the level of the original roof (see Picture 4). In this configuration, rainwater that accumulates on the front side of the original roof, pours onto the lower roof in a waterfall-like manner, and then streams off the edge of the lower roof. However, some rainwater does splash against the exterior wall component, between the original roof and the lower roof installed for the building addition. In the BEHA's experience, seams between sections of a building that are constructed at different times are usually vulnerable to breach by rainwater. In this case, water penetration has occurred, as evidenced by the water damaged ceiling tiles. A rubber membrane should be installed in this vertical section of roof to provide a continuous surface for rainwater transfer. A gutter downspouts system should also be installed to direct rainwater away from the vulnerable wall section between the original and lower roof.

The roof appears likely to form ice dams during winter months, which can also be a source of water damage. Ice dams form when snow in contact with the upper section of the roof melts, then refreezes on the lower portion of the roof. Melting occurs as a result of heated air generated from occupied spaces and the HVAC system. The heated air gathers in the peak of the roof, which warms the roofing material above water's melting point (32^{o} F). As water rolls down the sloped roof, it freezes into ice when it comes into contact with roof materials on the lower section of the roof that are below 32^{o} F. This ice creates a dam, which then collects and holds melting snow or rainwater against the roof shingles. Pooling water can then penetrate through the roof materials via cracks and crevices, resulting in wetting of the interior of the building. In order to prevent ice dams, a combination of methods are used. For example, the space between rafters in the ceiling can be insulated to prevent air movement and heat loss. The junction between the original building and the addition could not be examined during the assessment. However, if the wall of the original building extended below the level of the peak of the addition roof, a space is created where heated air may accumulate (see Figure 1). Heat can also accumulate in this space and start the ice dam creation cycle, particularly if attic insulation were inadequate. The problem is further compounded if insulation were moistened as a result of the ice dams. The ability of insulation to prevent temperature transfer is decreased if the material becomes moistened. The loss of temperature control can increase heat transfer to the roof surface, creating larger ice dams and more water penetration. Water damaged ceiling tiles, insulation backing and adhesive can serve as mold growth media. The conditions contributing to the creation of the ice dams should be corrected to prevent moisture problems.

Several additional conditions exist that may result in water penetration into the building. The southwest corner of the roof appears to have a rubber membrane protruding upwards, instead of being fastened to the wall system (see Picture 15). Detachment of the rubber membrane from the wall system prevents the membrane to function as designed. Rather than preventing water entry, the unfastened rubber membrane allows water to penetrate the building.

Another source of moisture penetration is chronic water damage to the exterior wall system/slab at the rear of the building (see Picture 16), resulting from prolonged contact with pooling rainwater. The roof at the rear of the building is outfitted with a drainage system that is connected to downspouts. Downspouts are configured to allow rainwater to accumulate at the base of the slab at the rear of the building (see Picture 17). This causes chronic wetting of the exterior wall. Downspouts should be designed to direct rainwater *away* from the base of the building to prevent rainwater from penetrating through the slab/exterior wall seam into the building interior. Water penetration can cause the moistening of GW and result in mold growth.

An additional source of exterior wall moistening is the location of condensation drains for the HVAC system. The condensation drain for the original building is located several feet above a cement slab (see Picture 18), allowing water to continuously moisten the exterior wall (see Picture 19). Condensation drains for the addition appear to empty directly onto cedar shingles. The configuration of both condensation drains produce chronic wetting of the exterior wall, which may result in moisture penetration into the building.

Several areas also have a number of plants (see Picture 20). Plant soil, standing water and drip pans can be potential sources of mold growth. Drip pans should be inspected periodically for mold growth and over watering should be avoided.

Other Concerns

AHUs are normally equipped with filters that strain particulates from airflow. In order to decrease aerosolized particulates, disposable filters with an increased dust spot efficiency can be installed. The dust spot efficiency is the ability of a filter to remove particulates of a certain diameter from air passing through the filter. Filters that have been determined by ASHRAE to meet its standard for a dust spot efficiency of a minimum of 40 percent would be sufficient to reduce airborne particulates (Thornburg, 2000; MEHRC, 1997; ASHRAE, 1992). Note that increased filtration can reduce airflow produced by the heat pump by increased resistance. Prior to any increase of filtration, each AHU should be evaluated by a ventilation engineer to ascertain whether it can maintain function with more efficient filters.

The design of the AHUs in the new addition does not allow for installation of filters within or on the unit. Filters for this system are installed within the return vent frame. Increasing the efficiency of filters would most likely result in a degradation of the ventilation system's ability to distribute air, which would in turn, degrade air quality.

Conclusions/Recommendations

The conditions found within the building raise a number of indoor air quality concerns. Rainwater penetration has caused damage to the building interior. Water damage to the GW has produced visible mold growth. Outward signs of water damage exist in GW and carpeting beneath windowsills. In addition, building occupants reported the replacement of ceiling tiles, which suggests previous water damage to the ceiling system. Furthermore, the lack of exhaust ventilation results in air being re-circulated by the AHUs. The current mechanical ventilation system does not have an exhaust system which is necessary to remove environmental pollutants from within the building. This can result in a buildup of dust, dirt, and other pollutants in the indoor environment.

To remedy building problems, a three-phase approach consisting of immediate (short-term) measures to improve air quality; long-term measures that will require planning and resources to adequately address the overall indoor air quality concerns; and additional remediation measures to repair/renovate the water damaged sections of the building.

Short Term Recommendations

1. Remove and replace any mold contaminated/water damaged GW, insulation, carpeting and ceiling tiles that are in either the ceiling system or along exterior walls and all affected window sills. This measure will remove actively growing mold colonies that may be present. Remove mold contaminated materials in a manner consistent with recommendations found in "Mold Remediation in Schools and Commercial Buildings" published by the US Environmental Protection Agency (US EPA, 2001).
2. Remove rubber baseboard coving during carpet removal and examine for fungal growth. If colonized with fungal growth, remove and replace up to six inches of GW along base of wall in accordance with recommendations found in "Mold Remediation in Schools and Commercial Buildings" (US EPA, 2001).

3. Properly seal all window frames and seams in exterior wall of original building.

4. Examine the feasibility of installing a gutter downspout system underneath the edge of the original building's roof at the front of the building.

5. Add extensions to condensation drains to deliver water to the ground without splashing.

6. Remove window boxes on windows of the addition.

7. To maximize air exchange, the BEHA recommends that all ventilation systems that are operable throughout the building operate continuously during periods of occupancy independent of thermostat control. To increase airflow in classrooms, set univent controls to "high". Set univent thermostats to the fan "on" position to operate the ventilation system continuously during the workday.

8. Once both the fresh air supply and exhaust ventilation are functioning, the systems should be balanced by a ventilation engineering firm.

9. Examine the feasibility of directing downspout water away from the base of the exterior wall.

    a. Improve the grading of the ground away from the foundation at a rate of 6 inches per every 10 feet (Lstiburek & Brennan, 2001).

    b. Install a water impermeable layer on ground surface (clay cap, asphalt, cement) to prevent water saturation of ground near foundation (Lstiburek & Brennan, 2001).

10. Consider reducing the number of plants away from univents in work areas. Avoid over-watering and examine drip pans periodically for mold growth. Disinfect with an appropriate antimicrobial where necessary.

11. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations). Consider obtaining a vacuum cleaner equipped with a high efficiency particulate arrestance (HEPA) filter to trap respirable dusts.

Long Term Recommendations

1. Examine the feasibility of installing a filter rack in the AHU system nearest to the AHU fan to filter both indoor/outdoor air and increase HVAC filter efficiency. Note that prior to any increase of filtration, each unit should be evaluated by a ventilation engineer so as to whether they can maintain function with more efficient filters.
2. Examine the feasibility of installing flashing along the base of the windows of the addition.

Renovations/GW Removal

In order to avoid potential mold and related spore movement during remediation of the basement area, the following recommendations should be implemented to reduce contaminant migration into occupied areas and to better understand the potential for mold to impact indoor air quality. We suggest that these steps be taken on any renovation project within a public building:

1. Establish communications between all parties involved with remediation efforts (including building occupants) to prevent potential IAQ problems. Develop a forum

for occupants to express concerns about remediation efforts as well as a program to resolve IAQ issues.

2. Develop a notification system for building occupants immediately adjacent to (and above) the basement record storage area to report remediation/construction/ renovation related odors and/or dusts problems to the building administrator. Have these concerns relayed to the contractor in a manner that allows for a timely remediation of the problem.
3. When possible, schedule projects which produce large amounts of dusts, odors and emissions during unoccupied periods or periods of low occupancy.
4. Disseminate scheduling itinerary to all affected parties. This can be done in the form of meetings, newsletters or weekly bulletins.
5. Obtain Material Safety Data Sheets (MSDS) for all remediation/ decontamination materials used during renovations and keep them in an area that is accessible to all individuals during periods of building operations as required by the Massachusetts Right-To-Know Act (MGL, 1983).
6. Consult MSDS' for any material applied to the effected area during renovation(s) including any sealant, carpet adhesive, tile mastic, flooring and/or roofing materials. Provide proper ventilation and allow sufficient curing time as per the manufacturer's instructions concerning these materials.
7. Use local exhaust ventilation and isolation techniques to control remediation pollutants. Precautions should be taken to avoid the re-entrainment of these materials into the building's HVAC system. The design of each system must be assessed to determine how it may be impacted by renovation activities. Specific HVAC

protection requirements pertain to the return, central filtration and supply components of the ventilation system. This may entail shutting down systems (when possible) during periods of heavy construction and demolition, ensuring systems are isolated from contaminated environments, sealing ventilation openings with plastic and utilizing filters with a higher dust spot efficiency where needed (SMACNA, 1995).

8. Seal utility holes, spaces in roof decking and temporary walls to eliminate pollutant paths of migration. Seal holes created by missing tiles in the ceiling temporarily to prevent renovation pollutant migration.

9. Seal hallway doors with polyethylene plastic and duct tape. Consider creating an air lock of a second door inside the remediation spaces to reduce migration.

10. If possible, relocate susceptible persons and those with pre-existing medical conditions (e.g., hypersensitivity, asthma) away from the general areas of remediation until completion.

11. Implement prudent housekeeping and work site practices to minimize exposure to spores. This may include constructing barriers, sealing off areas, and temporarily relocating furniture and supplies. To control for dusts, a high efficiency particulate air filter (HEPA) equipped vacuum cleaner is recommended. Non-porous materials (e.g., linoleum, cement, etc.) should be disinfected with an appropriate antimicrobial agent. Non-porous surfaces should also be cleaned with soap and water after disinfection.

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http://www.wunderground.com/history/airport/KHYA/2003/6/22/DailyHistory.html

Picture 1

The Original Structure

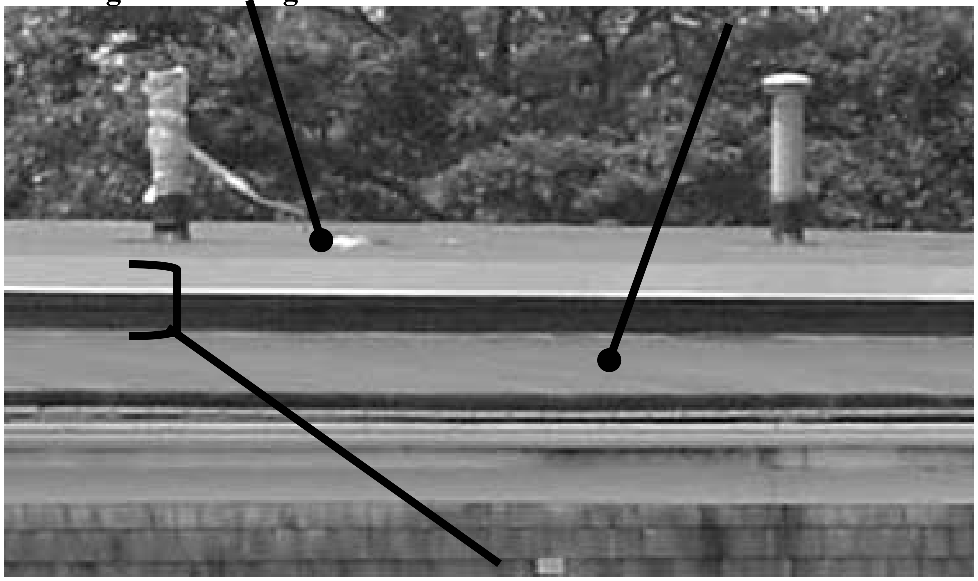
Picture 2

Rubber Membrane Peaked Roof Over Original Building

Picture 3

The Addition

Picture 4



The Original Building and Addition's Roof Junction

Picture 5

Windows Installed in Exterior Walls of Original Building

Picture 6

Gypsum Wallboard Installed In Manner to Form Windowsills

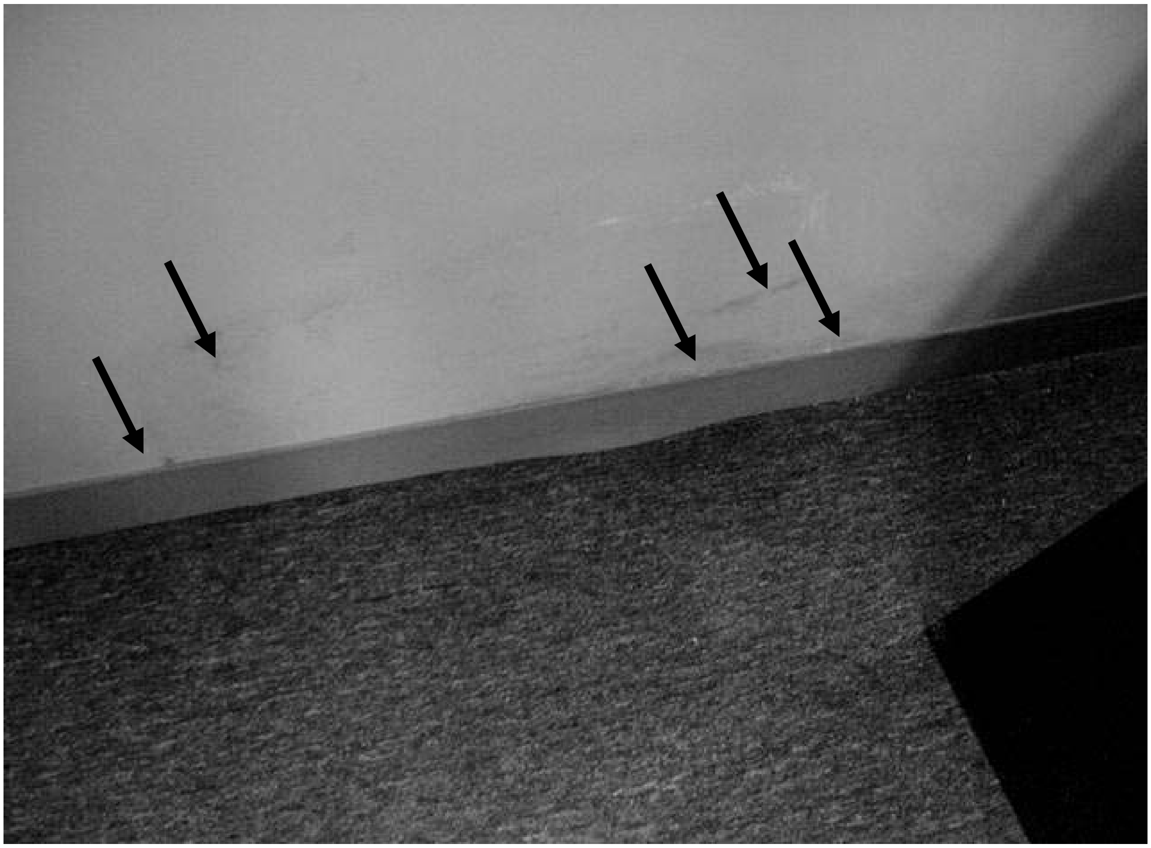
Picture 7

Window Showed Sign of Bubbling and/or Efflorescence

Picture 8

Window Showed Sign of Bubbling and/or Efflorescence

Picture 9



Possible Mold Colonization of GW in Room 104

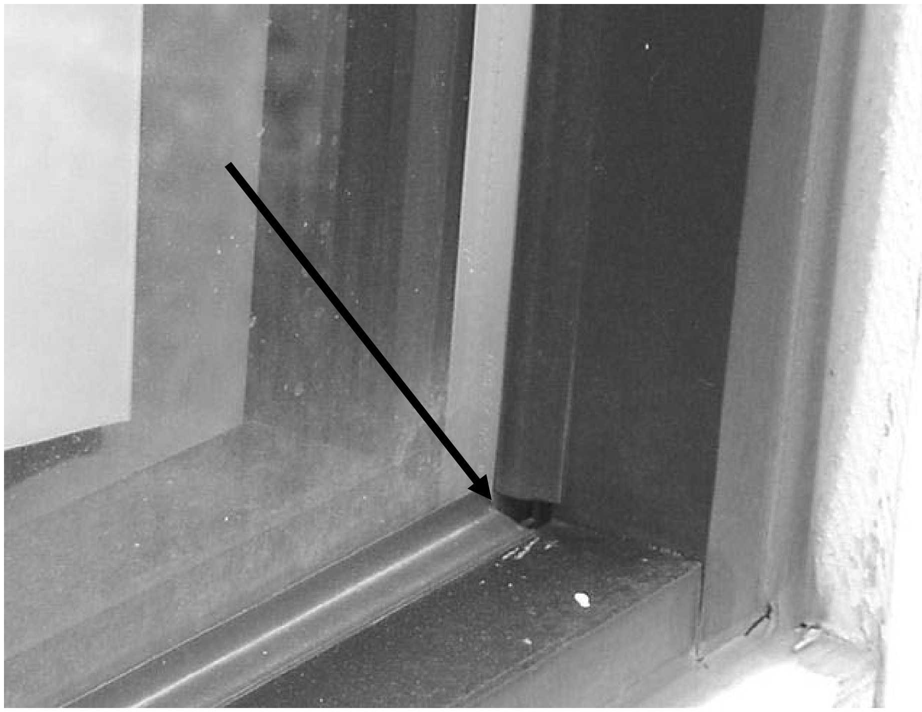
Picture 10a

Original Building Windows with Holes around the Frames

Picture 10b

Seal Doorway with Missing Sealant

Picture 10c



Space in Window Gasket

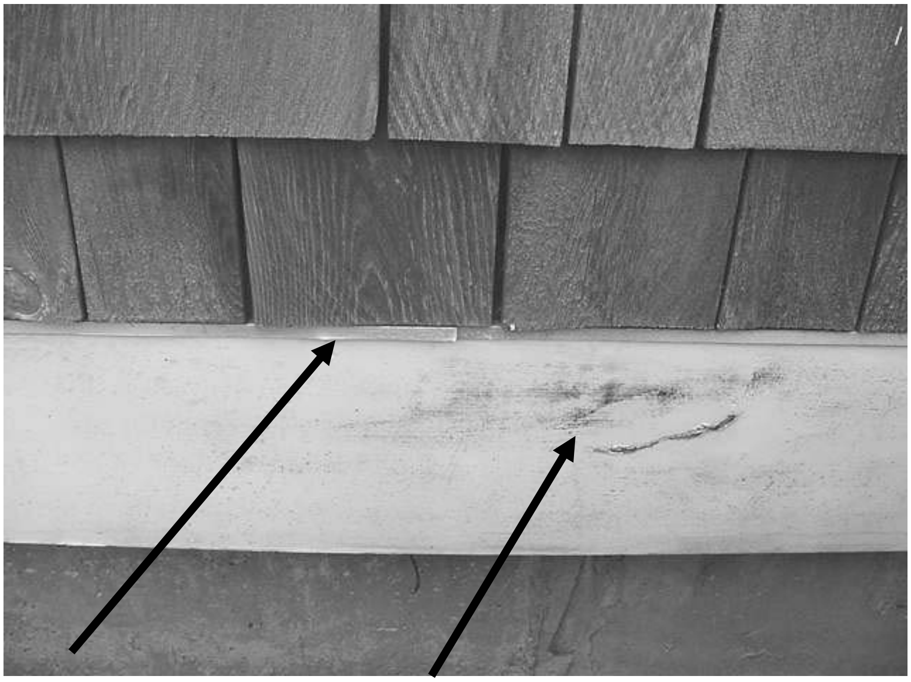
Picture 11

Exterior Cladding of the Addition

Picture 12

Flashing Installed along the Top of Window Frame

Picture 13



Flashing **Mold**

Flashing Installed along Shingle/Planking Junction above the Building Slab, Note Possible Mold on Plank

Picture 14

The Lack of Flashing beneath the Window Frames of the Addition

Picture 15

Non-Adhered Membrane at Southwest Corner of the Roof

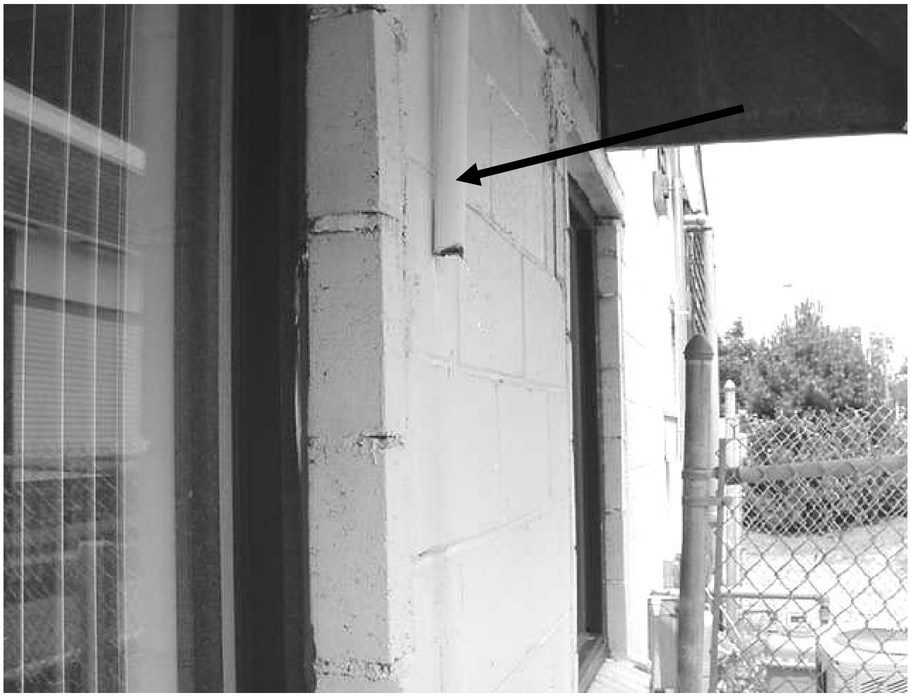
Picture 16

Pooled Rainwater at the Rear of the Building

Picture 17

Downspouts Are Configured To Allow Rainwater to Accumulate at the Base of the Slab at the Rear of the Building

Picture 18

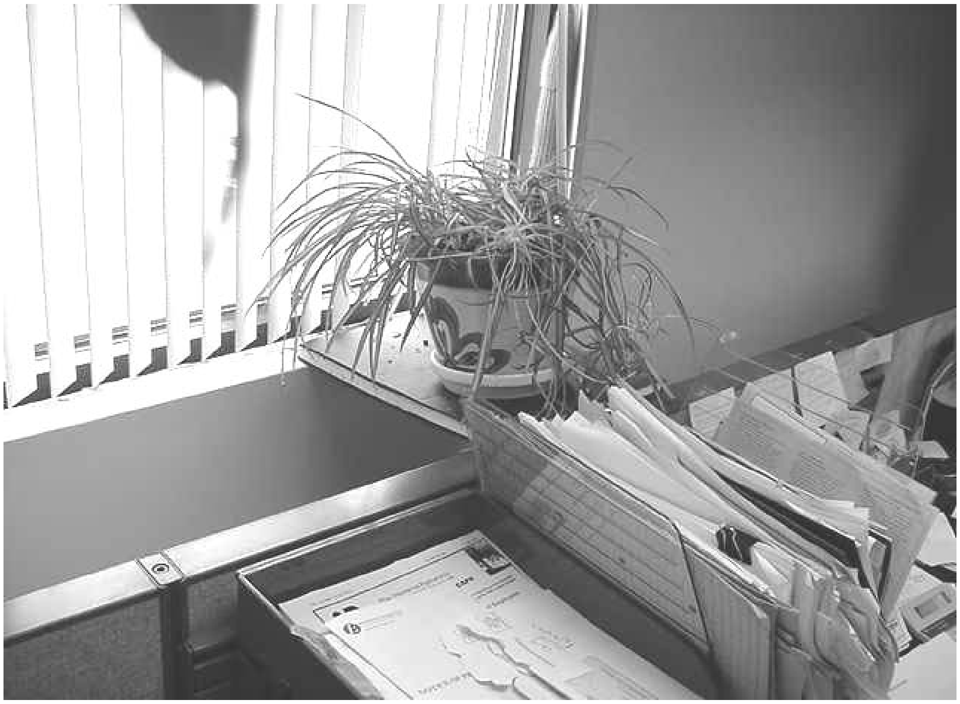


Condensation Drain for the Original Building Is Located Several Feet above A Cement Slab

Picture 19

Effects of Condensation Moistening the Exterior Wall

Picture 20



Plant on Work Area

TABLE 1

Indoor Air Test Results – Career Opportunities Building, Hyannis, MA **June 27, 2003**

Location	Carbon Dioxide (*ppm)	Temp. (°F)	Relative Humidity (%)	Occupants in Room	Windows Openable	Ventilation		Remarks
						Supply	Exhaust	
Outside (Background)	481	77	63					
105	1220	78	48	15	N	Y	Y	3 WD-CT; 3/4 WDWF; 21 computers; DO
106	905	78	70	15	N	Y	Y	13 computers; DO
104	915	70	48	5	N	Y	Y	14 computers; 1/2 WDWF; DO; photocpoier
Waiting room	902	75	43	4	N	Y	Y	Photocopier
150	847	79	29	3	N	Y	Y	1/1 WDWF; DO
152	845	73	43	0	N	Y	Y	1/1 WDWF; DO
153	844	73	46	1	N	Y	Y	Plant
154	878	73	46	0	N	Y	Y	1/1 WDWF
185	856	73	46	3	N	Y	Y	1/1 WDWF

*** ppm = parts per million parts of air**
WDWF = Water damaged window frame
WD-CT = Water damaged ceiling tile
DO = Door open

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

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						Supply	Exhaust	
186	881	73	47	3	N	Y	Y	1/1 WDWF; plant debris
182	919	73	48	0	N	Y	Y	
190	864	72	48	1	N	Y	Y	
179	879	73	40	0	N	Y	Y	
194	830	72	48	0	N	Y	Y	1/1 WDWF
SW corner	839	72	48	0	N	Y	Y	1/1 WDWF; plant
199	859	72	49	0	N	Y	Y	1 WDWF
175	845	73	49	2	N	Y	Y	Plants; DO
168	905	73	49	2	N	Y	Y	2 WD-CT; DO

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						Supply	Exhaust	
155	860	72	48	1	N	Y	Y	DO
128	935	73	49	1	N	Y	Y	DO
127	867	72	49	1	N	Y	Y	DO
126	846	72	57	0	N	Y	Y	DO
Kitchen	939	75	55	2	N	Y	Y	
124	891	74	53	1	N	Y	Y	
114 Main Frame	920	72	53	1	N	Y	Y	
117	875	73	50	0	N	Y	Y	4 WDWF
141	879	73	49	0	N	Y	Y	1 WDWF
136	895	73	49	1	N	Y	Y	Plants; 1 WDWF

*** ppm = parts per million parts of air**
WDWF = Water damaged window frame
WD-CT = Water damaged ceiling tile
DO = Door open

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 1

Indoor Air Test Results – Career Opportunities Building, Hyannis, MA **June 27, 2003**

Location	Carbon Dioxide (*ppm)	Temp. (°F)	Relative Humidity (%)	Occupants in Room	Windows Openable	Ventilation		Remarks
						Supply	Exhaust	
108	833	73	53	0	N	Y	Y	DO
107	806	74	52	0	N	Y	Y	

*** ppm = parts per million parts of air**
WDWF = Water damaged window frame
WD-CT = Water damaged ceiling tile
DO = Door open

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
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Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

Figure 1

Configuration of Original Building and Addition's Junction that May Lead to Heat Accumulation and Ice Dam Generation

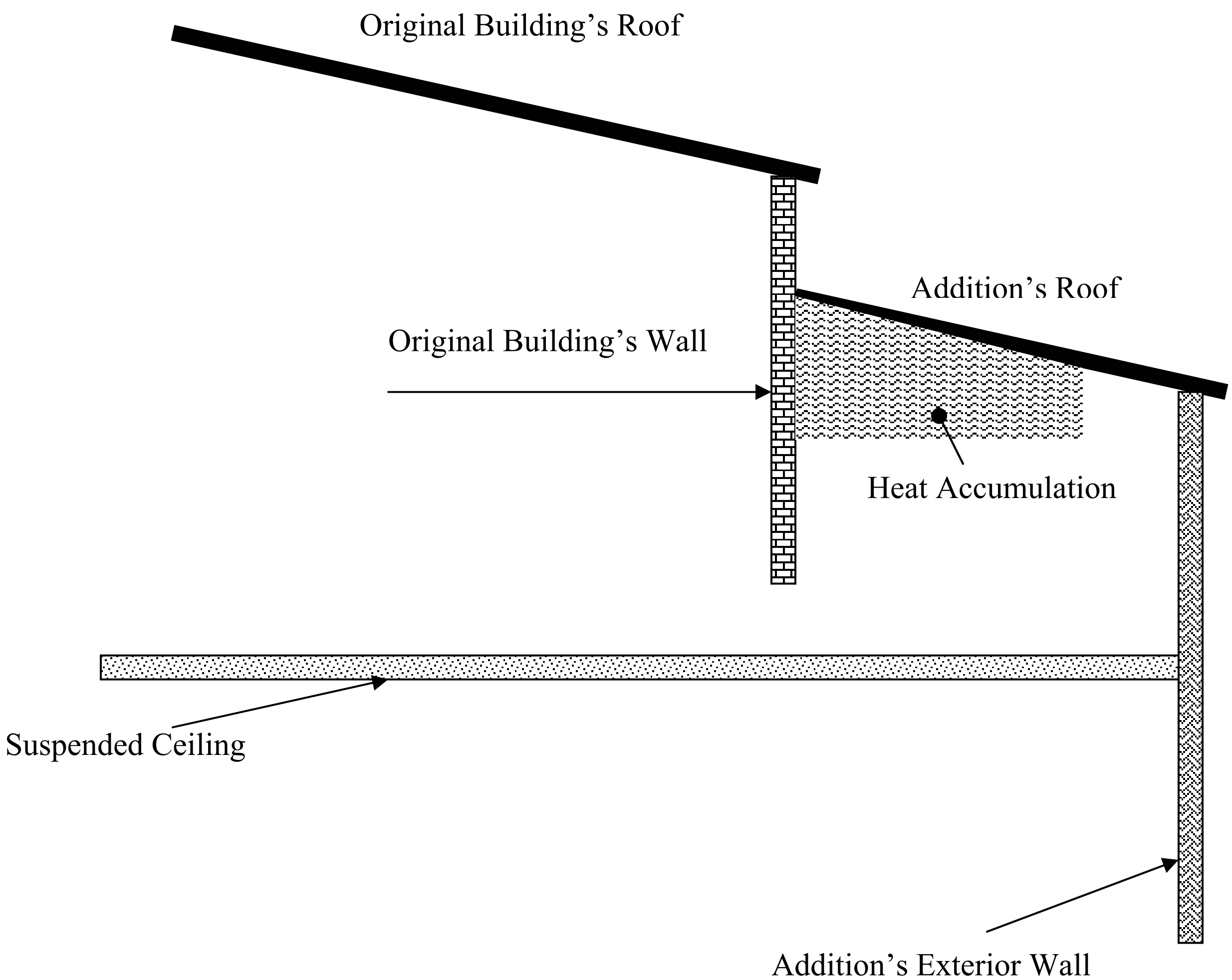

Figure 2

Location of Water Damaged Ceiling Tiles Identified by Building Occupants